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Static Planning Analysis of Urban Energy Power System Based on Heuristic Algorithm

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Abstract: With the rapid development of cities in China, scientific management of urban energy systems has become a reality in order to ensure urban energy security, reduce energy costs, reduce environmental impact, and implement low-carbon city strategies. This paper aims to explore the static planning analysis of urban energy power system based on heuristic algorithm. Based on the analysis of the current situation of various types of power generation in the country, this paper takes the power system of Liaoning Province as the research object, and establishes the optimization objective function of the power system with the goal of the lowest total cost of power generation. First, through data collection and data calculation, the cost coefficients of the internal power generation cost, carbon emission cost, exhaust emission cost, land opportunity cost and reliability loss cost of various power generation energy sources are obtained. In this paper, several heuristic optimization algorithms are used to analyze the static design of urban power and multi-order network power systems, and the characteristics of the algorithms are summarized through the comparison and simulation of specific algorithms. Based on the characteristics of different-level classification resource allocation in multi-networks, this paper proposes a comprehensive algorithm to improve the system coordination speed and system performance.

1. Introduction

The overpopulation, corporatization and high energy consumption of cities have brought many problems, which also makes people think about the various new ideas of city managers such as "low carbon city", "green city", "sustainable city" and so on. However, the problems of urban energy systems cannot be solved by "eliminating headaches and sore feet." Adaptation, environmental protection, embodying harmony between man and nature, sustainable development, scientific and intellectual formulation of energy plans that reflect energy plans Social, economic, environmental, and resource integration development, especially advanced energy technology, new energy and renewable energy technology, Energy-saving technological changes, and even energy system changes, industrial systems, urban models and other measures. It can be said that urban energy system research is a comprehensive scientific problem, including energy engineering, urban planning, systems engineering, process, environmental engineering, transportation and space engineering, which must be solved through multi-party cooperation [1-2].

In the research of static planning analysis of urban energy power system based on heuristic algorithm, many scholars have studied it and achieved good results, for example : Erolu H represents the randomness of wind power with probability, and studies the power flow in the wind power system. According to the historical statistical data of wind speed in different regions, the wind speed is discretized into a multi-scenario probability model. The series expansion method is used to derive the power flow analysis and evaluation model of the power system considering the randomness of wind power, and various details have been improved [3]. Diab AAZ gives the computational complexity theory for algorithms to solve optimization problems or decision problems. In terms of computational complexity theory, the question of whether P is equal to NP is still a major problem in the world scientific community [4].

This paper provides a basic framework and appropriate parameters for building a power system model and develops a deterministic power system design model. Based on this framework, a Beijing energy planning model with spatial uncertainty is developed, and the energy-saving renovation of existing buildings is introduced into the model as a virtual energy technology to analyze policy implementation. Combined with the test statistics method, the prediction probability of medium and long-term demand power is realized, and the obtained random information is input into CCIESM. In this paper, several uncertain energy system planning models are established to study the real urban energy system and to study the decision response under uncertainty to reduce the decision risk. Related models and methods are available for reference in other studies. This paper mainly focuses on the spatial uncertainty and randomness of urban energy systems, but the actual situation is not limited to this.

2. Research on Static Planning Analysis of Urban Energy Power System Based on Heuristic Algorithm

2.1 Optimization Principle of Power Energy Structure Optimization Model

(1) The principle of stability

With the gradual increase in the demand for electricity, as the infrastructure related to the national economy and people's livelihood, the requirements for the safe and stable supply of electricity are also getting higher and higher. The stability principle of power structure optimization in the power generation industry is mainly reflected in the supply stability of power energy. Adequate and effective power supply can only be guaranteed if the supply of power generation energy is sufficient. If the energy supply is not timely, it will directly lead to the stagnation of power production, which will seriously affect the power supply and people's daily life. In addition, the world is vigorously promoting renewable energy power generation, and various types of renewable energy such as hydropower, wind power, nuclear power and solar energy are more and more widely used in the power generation industry, and the development trend is rapid. However, the use of renewable energy for power generation also has drawbacks, that is, its stability is uncontrollable, and power sources with serious lack of stability will have a negative impact on the security of power supply in the power generation industry. Therefore, in the process of optimizing the power energy structure, the stability of power generation should be taken as an important consideration and principle [5-6].

(2) Low-carbon principle

As a clean, efficient and stable secondary energy, and compared with fossil energy such as coal, oil, and natural gas, electric energy has great advantages in environmental sustainability, and fossil energy will emit a large amount of carbon dioxide and smoke during the power generation process. Polluting gases such as dust are not conducive to the sustainable development of the power generation industry. Renewable energy power generation is clean and pollution-free, with almost no carbon emissions. Therefore, it is necessary to fully consider the low-carbon principle, increase the proportion of renewable energy power generation, reduce the proportion of traditional fossil energy power generation, adjust and optimize the power generation structure, and reduce carbon dioxide emissions from the source. On the other hand, it is necessary to encourage the research on coal-fired power generation and the introduction of clean, efficient and advanced power generation technologies, such as carbon capture, desulfurization and denitrification technologies, and increase policy support to reduce carbon dioxide emissions from traditional fossil energy in the power generation process, thereby To achieve the overall low-carbon development of the power generation industry. Therefore, whether it is low-carbon energy power generation or low-carbon technology power generation, the low-carbon principle should be followed in the process of power generation and the structural optimization of power energy [7-8].

(3) The principle of operability

In the development of the power generation industry, not only the stability and low-carbon nature of the power supply, but also the operability of the adjustment and optimization of the power energy structure must be considered. Electricity is a core industry related to the national economy and people's livelihood and social and economic development. In the process of optimizing it, the characteristics of local energy resources, the actual bearing capacity of the environment, the specific requirements of environmental protection, and the advanced nature of power generation technology must be comprehensively considered the elements of. Taking hydropower generation as an example, although hydropower is cleaner than thermal power and more stable than wind power, it has great potential for development initially. However, in the process of developing hydropower, consideration should be given to geographical location, ecological protection, population migration, etc. Due to various factors, if the local area does not have the advantages of the geographical environment and water resources for the development of natural large-scale hydropower stations, forcible development will have a serious negative impact on the local area. For wind power generation, consideration should be given to wind power entering the construction area, storage and grid connection of wind energy, and solar power generation should consider the geographical location and installation technology of photovoltaic panels, as well as safety grid connection and other issues. In general, when optimizing the power structure of the power generation industry, it is necessary to fully consider the local energy resource endowment, the power generation technology of various power generation sources, and the installation requirements of various generator sets. To optimize, not only to ensure the safe and stable supply of electricity, but also to ensure the overall low-carbon, clean and sustainable development of the power generation industry [9-10].

(4) The principle of economy

The economics of optimizing the power energy structure refers to the rational use of costs in the process of resource input and use, and cost savings as much as possible. Production and economic benefits. The optimization of the power energy structure in the power generation industry should not only consider the low carbon and stability of production, but also the principle of economy. In general, compared with traditional fossil energy, the cost of renewable power generation is higher, and the choice of thermal power generation can save more power generation costs. However, with the improvement of public awareness of the environment and the generation of environmental costs such as carbon emission rights trading, the comprehensive power generation cost of traditional energy power generation is getting higher and higher, which will greatly affect the decision-making of power industry investors influences. With the advancement of renewable energy power generation technology and the rise of environmental costs such as carbon emission rights trading, vigorously developing clean energy can bring greater economic and environmental benefits to the power generation industry. Long- term choice [11-12].

2.2 Power and Energy Structure Optimization Objective Function Data Analysis

In order to effectively use the power energy structure optimization objective function and make the various cost functions of the total cost of power generation more pertinent, data search is essential. By searching the China Statistical Yearbook, the China Energy Statistical Yearbook, the Environmental Statistical Yearbook, the data reports issued by the National Development and Reform Commission, the National Energy Administration, and the China Electricity Council, as well as various documents and related materials, the power generation costs of various domestic energy power generation technologies were collected and counted. Relevant basic data, so as to complete the calculation and analysis of the total power generation cost of various power generation energy [13-14].

(1) Internal power generation cost coefficient

The internal power generation costs of various power generation sources are mainly composed of investment costs, fuel costs and operation and maintenance costs. Through the collection and calculation of the internal costs of thermal power, wind power, hydropower, nuclear power and solar power generation technologies in my country, the relevant data are obtained. Internal power generation cost data for power generation technologies.

(2) External power generation cost coefficient

The external power generation costs of various power generation technologies are mainly composed of carbon dioxide emission costs, exhaust gas emission costs, land opportunity costs and reliability loss costs. The following is a partial analysis of these types of external power generation costs.

1) CO2 emission cost

In the process of thermal power generation, a large amount of carbon dioxide will be emitted into the air, and clean electric energy, such as wind power, hydropower, nuclear power, solar power, etc., can be approximated as carbon-free.

Carbon emission is the main aspect of thermal power generation affecting the environment, and carbon dioxide emission reduction has also become an important responsibility of the power generation industry, and it is also an important aspect to be optimized [15-16].

$$C_{CO2} = \sum_{j=1}^{n} x_j \times b_j \quad (1)$$

Where the C_{CO2} cost of carbon dioxide emissions

x is the carbon emission intensity of the j-th generator set:

b is the comprehensive coefficient of CO_2 environmental damage, that is, the CO_2 environmental treatment cost per unit weight.

2) Exhaust emission cost

The emission of sulfur dioxide, nitrogen oxides and dust is an important part of air pollutants in my country. By consulting the Statistical Yearbook, the exhaust gas emissions from the electricity, heat production and supply industries have been increasing year by year since 2000.

$$C_F = \sum_{m=1}^{N} (P_m \times \alpha_m \times \omega_m + P_m \times \beta_m \times \theta_m + P_m \times \delta_m \times \varepsilon_m) \quad (2)$$

The total cost of exhaust emission in the formula; C_F

Pm is the output power of the mth generator set;

$\alpha_m, \beta_m, \delta_m$ is the emission coefficient of three types of pollutants;

$\omega_m, \theta_m, \varepsilon_m$ of three types of pollutants [17-18].

3. Research Design Experiment of Static Planning Analysis of Urban Energy Power System Based on Heuristic Algorithm

3.1 Research on Deterministic Energy System Planning

The goal of the energy system optimization model is to minimize the energy system cost, including energy supply cost, energy processing cost, energy conversion cost and so on. The constraints of the model mainly include energy supply and demand balance constraints, energy processing and conversion technology constraints and energy development constraints.

3.2 Experimental Design

Based on the regional electricity consumption in the past five years, plus three industrial growth values and population increments, this paper conducts electricity demand analysis, and analyzes the accuracy of the fitting data by comparing the modeled fitted electricity with the actual electricity. The second is to study the node runaway risk node of voltage.

4. Experimental Analysis of Static Planning Analysis of Urban Energy Power System Based on Heuristic Algorithm

4.1 Power Demand Model

Based on the electricity consumption data from 2017 to 2021 and the three industrial added value and population data modeling, this paper uses the modeling to fit the electricity consumption. The comparison between the fitting results and the actual electricity consumption is shown in Table 1.

Table 1: Actual electricity consumption and fitted electricity quantity

	2017	2018	2019	2020	2021
Actual electricity consumption	87.2	95.4	102.4	113.5	131.2
Fit the power	87.6	95.2	102.3	114.1	132.0

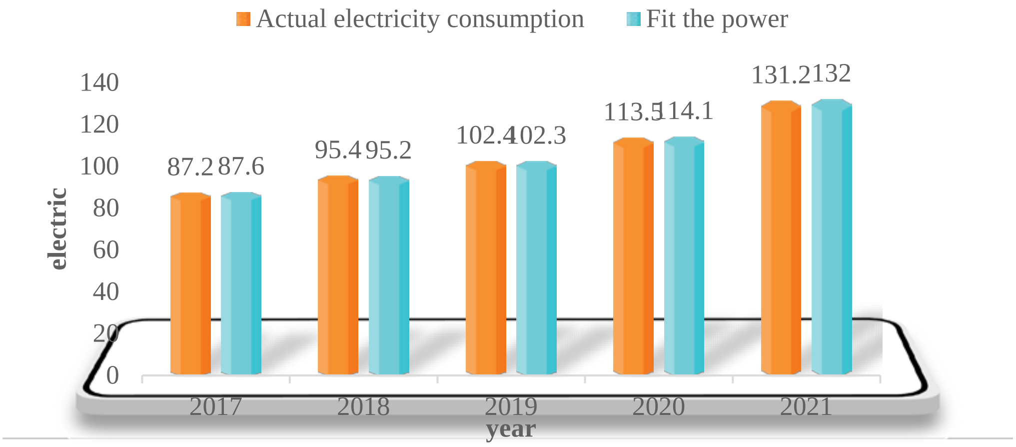

Figure 1: Comparison of the fitted electricity quantity and the actual electricity consumption in the past five years

It can be seen from Figure 1 that with the growth of population and industrial development, the regional electricity consumption is increasing year by year. Through the fitting electricity model of this paper, the fitting result is ideal, and the maximum error between the fitting result and the actual electricity consumption is similar. If it exceeds 1%, it can effectively predict the electricity consumption of the future area.

4.2 Instability Risk of Nodes

This paper studies the low instability risk of static voltage, and selects six nodes with higher risk for research and analysis. The maximum value of the static voltage is selected as the overall instability risk value of the system. The system data is shown in Table 2.

Table 2: Node at the risk of static voltage instability

	14	16	18	27	29	30
Risk of static voltage instability	0.0051	0.0049	0.0047	0.0055	0.1502	0.1531

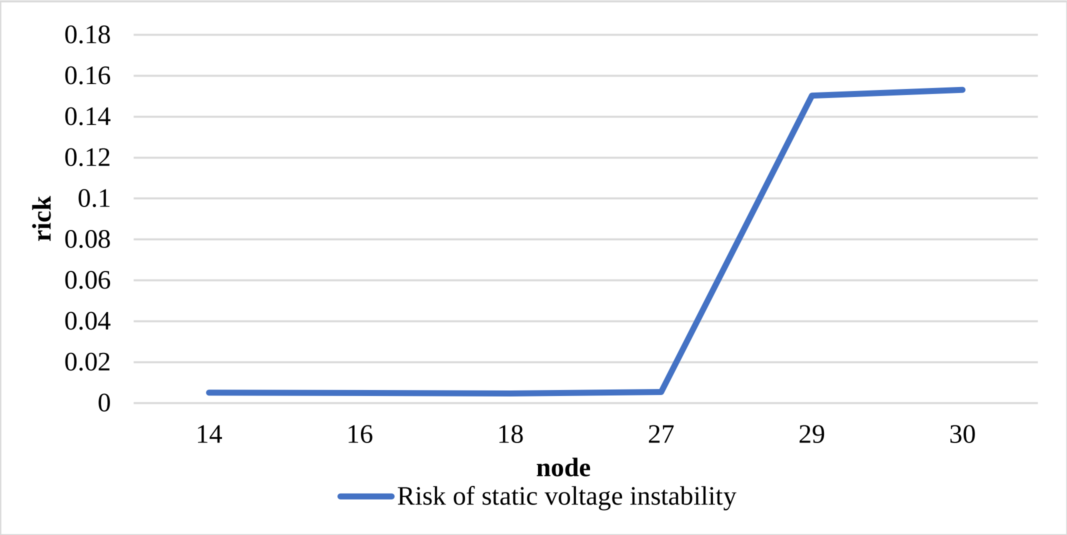

Figure 2: Comparison of the changes in the risk of instability at each node

From Figure 2, it can be found that among the influence of wind farm power fluctuation on the voltage stability of each load node, the node with a greater risk of static voltage instability is the node that is closer to the wind farm grid-connected node, which is related to the uncertainty of the wind farm power. It is closely related to the characteristics of reactive power deficiency. Combined with the local actual wind speed probability density distribution, considering the randomness of wind farm output, a certain warning value L is selected. After that, this method can screen out weak nodes with instability risk in the system. Static voltage stability is assessed probabilistically.

5. Conclusions

The external constraints of resources and environment and people's pursuit of a livable environment, but from the literature reports, most of the research on the energy system is still a deterministic model. This paper conducts an in-depth analysis of various planning problems, proposes various meta-heuristic algorithms to solve these problems, and then shifts from decision planning to dealing with stochastic programming problems under uncertainty. Power systems and intelligent power management systems. With the rapid development of science and technology, the performance requirements of the lighting market are also constantly improving, and its visual applications will become more and more extensive. As technology develops, new opportunities will be opened up. In the future, we also need to improve or adjust the details of the functional parts of the system, improve the quality of the system, and serve the business.

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